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TOTAL OZONE TREND OVER CAIRO

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ABSTRACT:

A world wide interest in protecting ozone layer against manmade effect is now increasing.Assessment of the ozone depletion due to these activities depends on how much successful the separtion of the natural variabilities from the data.

The monthly mean values of total ozone over Cairo (30 05N) for the period 1968-1988, have been analyzed, using the power spectral analysis technique. The technique used in this analysis does not depend on a pre-understanding of the natural fluctuations in the ozone data. The method depends on increasing the resolution of the spectral peaks in order to obtain the more accurate sinusoidal fluctuations with wave-length equal to or less than record length. Also it handles the possible sinusoidal fluctuation with wave length greater than the record length.

The results show that: It is possible to detect some of the well known national fluctuations in the ozone record such as annual,semiannual,quasi biennial and quasi-quadrennial oscillations,in addition to some waves as 18, 6.years which are not known.

After separation the natural fluctuations from the ozone record,the trend analysis of total ozone over Cairo show that a decrease of about of -1.2% per decade has occurred since 1979.

INTRODUCTION:

There have been many statistical studies of global total ozone trends Detailed studies of the ozone trend Reinsel et al 1981 , 1984 , Bloomfield et al 1982, Bojkov et al 1984,1987,Tiao et al 1986 and Degorska et al 1988) indicate significant negative trend in winter at middle and high latitudes.

The statistical models used to obtain these trends are described in details in the Ozone Trend Panel (OTP) report. The models used to estimate ozone trend handled the regular variations, such as the annual cycle ,the QBO, the solar cycle,etc. These known variations were eliminated from the data records by forcing an appropriate series to the data,for example Degorska (1988) forces a number of series to express seasonal, semi-annual,annual,quasibiennial and 11 years cycles to Belsk data in the statistical analysis for ozone trend . Accordingly the estimated trend depends in the first place on a pre-understanding of these variabilities. Even so, elimination of these waves in this way may effect the estimated trend, since the oscillation period of these wave, eg QBO differs from one cycle to another.

In the present paper , we used the power spectral model designed by Hassan (1989),to estimate the ozone trend over Cairo for the period 1968-1988.

DATA:

Ozone observations at Cairo (30 05 N) have been carried out on routine basic since October 1967 using Dobson ozone spectrophotometer number 96.The monthly averages of total ozone, used in this study have been calculated after the recomputation of the whole observations using the results of the international intercomparisons (Belsk 1974, Boulder 1977 and Arosa 1986) and by applying the new technique in estimating the total ozone from the zenith sky observations Hassan 1984.

STATISTICAL TREATMENT:

This method depends on handling the

data regardless of any pre-expected periodicities to separate two kinds of wave such as:

A- Waves with oscillation periods equal to or less than the length of the available record.

B - Waves with oscillation period longer than the length of the record.

The first kind of waves have been found through the analysis, using the variable record length method of Schickedanz et al (1975). Each time we get the waves with the largest contribution. From these waves, we consider the one with minimum root square mean error from the actual data as a real wave in the record. After subtracting this wave from the actual data the analysis is repeated again to obtain the next one. This analysis continue until it reaches to waves with negligible contributions to the record. After eliminating this kind of waves which are equal or less than the record length , a curve fitting using a third order equation is applied to the residual. The second order equation resulting from differentiating the third order equation has been examined from point of view of its real roots. The maximum and minimum values of the roots indicate to the presence of wave amplitude equal half the difference between them and with oscillation period twice their time difference. These values of amplitude and oscillation period are taken as a first guess for a natural waves with oscillation period greater than the record length.

An iteration procedure is then used to get the best values for this waves. Subtracting this waves from the residual and by repeating the analysis again to detect any other waves longer than the record length, the remainder can give indication of any anthropogenic influence in the data.

RESULTS AND DISCUSSIONS:

The procedure mentioned above has been used for separating natural variabilities in the record, Eight waves have been found to be of great contribution to the data,(12, 216, 88,21,8,28, 56,6 months), with amplitudes equal to 18.96,8.51,5.1, 4.3, 3.6,3.3, 3.0, 2.6 D.U. respectively arranges in descending order according to their amplitudes. (see Figs.1a,2a)

Figure 1 represent the monthly average of the actual total ozone data for 1968-1988. It is clear from the figure that the annual oscillation has the greatest amplitude. Also these waves have semi-annual,quasibiennial,and quasiquadrenial oscillations.

Figure 2 shows a summations of eight-waves plus an over mean value.

Figure 3 and figure 4 show the twelve month running mean for both actual and estimated values. It is clear from the two figures that the actual data can be presented successfully by eight waves and a mean value.

Figure 5 shows the residuals, it is clear from the figure that there is a small negative trend in the record after 1979.

The above analysis shows that,there is a negative trend of about 1.2 percent per decade as from 1979.The value is comparable with the results obtained by Reinsel et al 1981,Bojkov et al 1984 ,1989, and others for this latitudinal belt using different statistical models.

CONCLUSION:

In this paper we summarized the main conclusions as:

It is possible to detect some of the well known natural variations in the record such as,annual,semiannual,quasi-biennial and quasiquadrennial oscillations, in addition to some waves (18 and 6.5 years),which are not known.

By separation the natural fluctuation mentioned above from the ozone data over Cairo,the analysis of trend shows that a decrease of about 1.2 percent per decade ,has been found from 1979.

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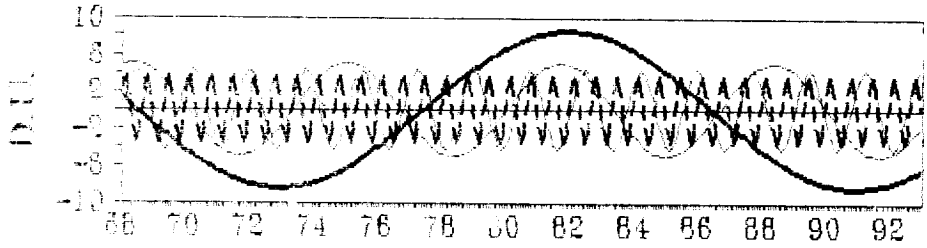
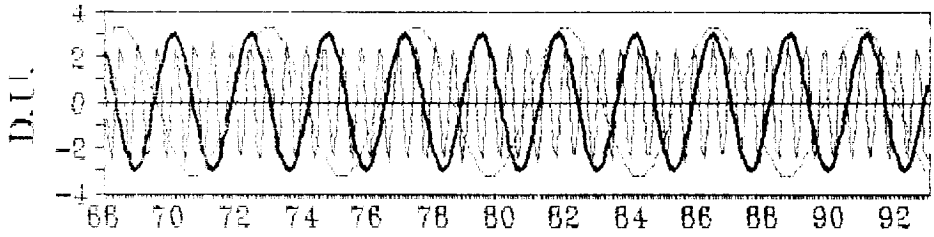
FIG.(1a) Waves 216, 88, 21, 8 Months of Total ozone over cairo



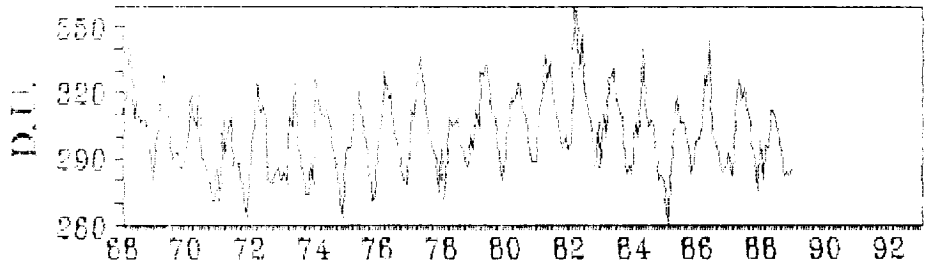
Years

FIG.(2a) Waves 28, 56, 6 Months of Total ozone over cairo



Years

Fig.(1)The Monthly Average of Actual Data (1968-1988)



Years

Fig.(2) Summation of Eight Waves Plus an Over Mean value

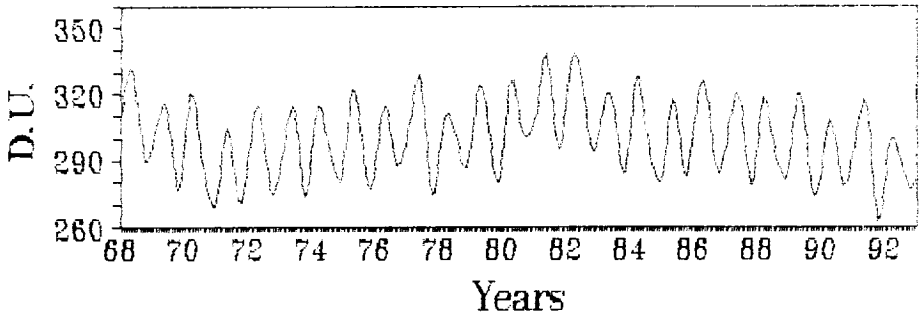


Fig.(3) Twelve Month Running Mean for The Actual Data

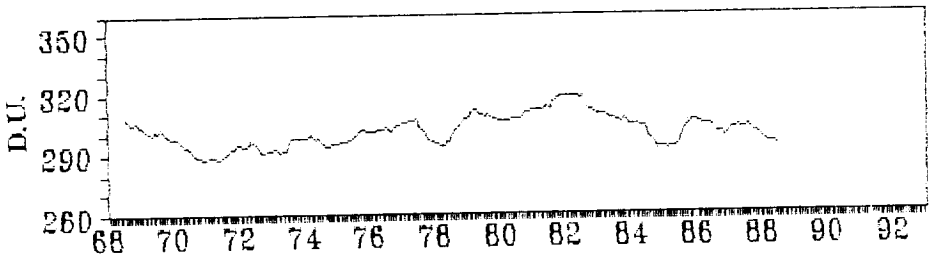


Fig.(4) Twelve Month Running Mean for The Forcast

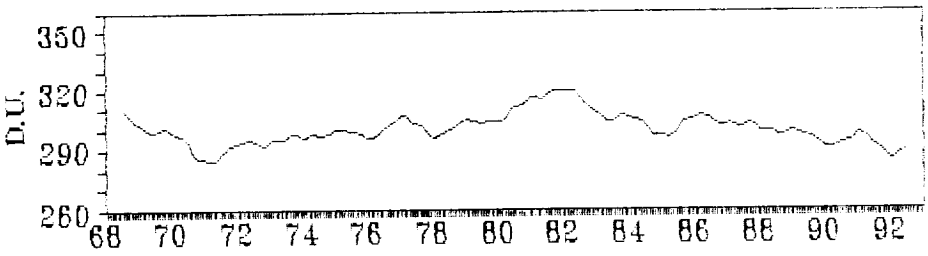


Fig.(5)The Residuals (Actual-Forcast)